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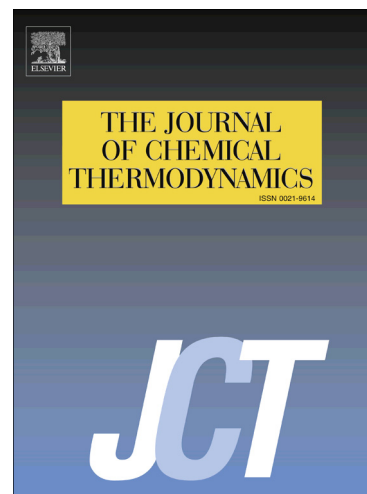
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Solubilities in aqueous solutions of the sodium salts of succinic and glutaric acid with and without ammonium sulfate

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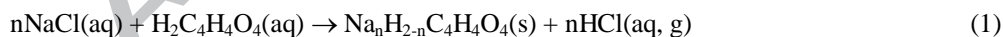
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Abstract. The aqueous solubility of the least soluble salts in mixtures of sodium hydrogen succinate, sodium succinate, sodium hydrogen glutarate, and sodium glutarate with and without ammonium sulfate present has been studied. Solubility temperatures were determined in solutions of known concentration using Differential Scanning Calorimetry. The identity of the least soluble solid was determined by a combination of X-ray crystallography and infrared spectroscopy. The identified solids included ammonium sulfate, sodium sulfate, sodium ammonium sulfate dihydrate (lecontite), sodium hydrogen succinate, sodium succinate hexahydrate, sodium hydrogen glutarate dihydrate, and ammonium hydrogen glutarate. Of the 16 series of solutions studied, lecontite was most frequently the least soluble solid.

Keywords: Ammonium Sulphate; Sodium Malonate; Sodium Succinate; Aqueous; Phase Diagram; Solubility

1 Introduction

Field measurements have shown that the major chemical components of aerosols in the free and upper troposphere (UT) include organic and inorganic compounds and mineral dust [1,2], with the most abundant inorganic components being ammonium and sulfate [3]. With respect to the organic fraction, dicarboxylic acids (DCA) have been found in a range of environments, particularly for aerosols that have undergone chemical aging [4]. Both primary organic and secondary organic aerosols have been found to contain DCA [3], and their concentration in aerosols is increasing [5]. Field measurements have shown that succinic and glutaric acids are among the most abundant DCA in atmospheric aerosols [5,6,7]. Mineral dust has also been observed in aerosols, especially under acidic conditions, where mineral dust components can be reacted to the aqueous phase through chemical aging [8, 9] The aqueous phase chemistry of aerosols can be enhanced by metals at the surface or reacted into the aerosol interior [8, 10]. The presence of organics, metals, and metal salts have been shown to be present in large numbers of aerosols in field studies with sources of sea spray (Na, Mg) [4,11,13], biomass burning (K) [14,15], and mineral dusts and meteoritic material (Na, K, Ca, Fe) [1,16,17,19]. Metal ions can displace hydrogen ions from organic acids to form carboxylate salts in atmospheric aerosols as shown by field and lab studies [11, 13,20,21]. As an example, a particle that experienced UT temperatures or dry conditions and contained dissolved NaCl and succinic acid could undergo the following:



where n equals one or two (corresponding to the number of acidic hydrogens present in the acid.) According to recent studies the HCl product is highly volatile, and the organic salt will remain in the particle since it has a much lower vapor pressure [13, 20]. The sodium oxalate salt could precipitate when the particle experiences either cold or dry conditions in the atmosphere [21]. While the solubilities of $\text{NaHC}_4\text{H}_4\text{O}_4$ and $\text{Na}_2\text{C}_4\text{H}_4\text{O}_4$ in water are well known [22], the impact of ammonium sulfate on solubility in solutions of the sodium succinates has not been investigated. The solubility of $\text{NaHC}_5\text{H}_6\text{O}_4$ in water has not been previously investigated to our knowledge, and that of $\text{Na}_2\text{C}_5\text{H}_6\text{O}_4$ has only recently been investigated [23]. In both cases the effect of ammonium sulfate on

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